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Exercise Testing and Exercise Rehabilitation for Patients with Atrial Fibrillation

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Abstract

Introduction and Purpose: Atrial fibrillation (AF) is a common cardiac arrhythmia associated with an increasing prevalence with advancing age. AF is associated with dyspnea, exercise intolerance and increased risk for clinical events, especially stroke and heart failure. This paper provides a concise review of exercise testing and rehabilitation in patients with persistent or permanent AF.

Clinical Considerations: The first goal in the treatment of AF is to reduce symptoms (eg, palpitations) and a fast ventricular rate. The second goal is to reduce the risk of a stroke. Exercise testing and rehabilitation may be useful once these goals are achieved. However, there are no large, randomized exercise training trials involving patients with AF, and what data are available comes from single-site trials, secondary analyses, and observational studies.

Exercise Testing and Training.—There are no specific indications for performing a graded exercise test in patients with AF; however, such testing may be used to screen for myocardial ischemia or evaluate chronotropic response during exertion. Among patients with AF, exercise capacity is 15% to 20% lower and peak heart rate is higher than in patients in sinus rhythm. Exercise rehabilitation improves exercise capacity, likely improves quality of life, and may improve symptoms associated with AF. Whole body aerobic exercise is recommended.

Summary.—AF is a common cardiac condition and in these patients, exercise rehabilitation favorably improves exercise capacity. However, prospective randomized controlled trials are needed to better define the effects of exercise training on safety; quality of life; clinical outcomes; and central, autonomic, and peripheral adaptations.

CONDENSED ABSTRACT

Atrial fibrillation (AF) is a common disorder. During exercise testing, exercise capacity is 15% to 20% lower and peak heart rate is higher than in patients in sinus rhythm. Exercise rehabilitation is recommended because it improves exercise capacity, likely improves quality of life, and possibly improves the clinical outcomes associated with AF.

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Keywords

Exercise; atrial fibrillation; rehabilitation

Atrial fibrillation (AF) is a common cardiac arrhythmia associated with an increasing prevalence with advancing age. This review provides a concise discussion of exercise testing and training/rehabilitation considerations for patients with persistent or permanent AF.

Epidemiology

Atrial fibrillation is observed in more than 3 million Americans, <2% of the population that is less than 65 years old, and ~10% of the population aged 65 yr and older.[1] Among people 75 to 84 years the prevalence of AF is 12%, and one-third of patients with AF are ≥80 yr of age.[1,2] The incidence of AF appears to be greater in people of European decent, with an approximate lifetime risk of 26% for men and 23% for women over the age of 40. Comparatively, the incidence of AF in African Americans appears to be lower, despite African Americans having a higher prevalence of the more common risk factors (eg, hypertension, diabetes).[1] There is a higher prevalence of AF in men compared to women, and women typically present with the condition at approximately 5 yr older than men.[1–4]

Interestingly, despite fewer risk factors, competitive athletes also are at an increased risk for developing AF. A meta-analysis of more than 9000 patients showed the risk for having or developing AF was 64% higher among athletes compared to the general population (odds ratio [OR] = 1.64, 95% confidence interval [CI] 1.10–2.43).[5] This increase in risk among athletes was observed in younger individuals (eg, <54 yr, OR = 1.96, 95% CI 1.06–3.65), but not people older than 54 yr (OR = 1.41, 95% CI 0.81–2.44). Higher volume, endurance-type activities (ie, long distance running) may also be associated with the increased risk for incident AF; whereas, weekly physical activity levels at or slightly above recommended guidelines (ie, 150 min of moderate-intensity activity per wk) appears to have protective properties.[6]

Background and Pathophysiology

The mechanism of AF is complex and involves 1 or more microreentrant foci of cardiac tissue, usually in the left atrium that results in multiple reentrant electrical circuits leading to fibrillation-like activity.[7] Patients with advanced age, hypertension, heart failure, diabetes, ischemic heart disease, valvular heart disease, left ventricular hypertrophy, left atrial enlargement, and hyperthyroidism are at an increased risk for developing AF.[1,8] Among athletes, the precise mechanism(s) responsible for the increased risk for AF is unclear and may include alterations in the autonomic nervous system and/or abnormalities in atrial structure or function due to the chronic pressure and volume overload that results from a sustained increase in cardiac output during exercise.

Atrial fibrillation is a complex disorder to manage and associated with exercise intolerance, reduced quality of life, frequent hospitalizations (~500,000 annually) and thromboembolic events. It is associated with a 5-fold increased risk for stroke, a 3-fold increased risk for heart failure, and a 2-fold increased risk for mortality.[1,2,9]

CLINICAL CONSIDERATIONS

Diagnosis

The diagnosis of AF should be suspected when patients have an irregular pulse on physical examination or irregular heart rhythm on ECG (electrocardiogram). Although palpitations, tachycardia, dyspnea and/or fatigue with exertion often accompany a new diagnosis of AF, they are not always present and are not required to make the diagnosis. When AF is suspected, a 12-lead ECG should be obtained to confirm the diagnosis. This will show no repetitive pattern in the RR interval (ie, an irregularly irregular pattern) and P waves will not be distinct. AF should not be confused with a pattern of sinus rhythm and frequent premature atrial contractions, which can often have an irregular heart rhythm but, unlike AF, will have distinct P waves for the sinus node-initiated beats.

In the rehabilitation setting, ECG telemetry can be the first indication of a potentially new diagnosis of AF. When a rehabilitation professional believes new onset AF is likely, consultation with a patient's physician is required for further evaluation. In an asymptomatic patient, an episode of AF should generally last at least 6 min before being considered a formal diagnosis,[9] which then usually involves an echocardiogram and laboratory testing to determine the cause. Identifying the duration/persistence of AF separates patients into 3 general patterns of disease (Table 1). This is an important step because each type has unique implications for treatment. In patients with intermittent palpitations and suspected AF, ambulatory outpatient ECG monitoring for several days or longer may be necessary to document bouts of AF.

Treatment Strategies

The initial goal in the treatment of AF is to reduce symptoms (eg, palpitations) and a rapid resting heart rate (HR). A patient's resting ventricular rate on initial presentation with AF is often between 120 and 150 beats/min, and is typically treated to reduce the rate to between 60 and 100 beats/min. First-line agents used to achieve rate control include beta-adrenergic blocking agents, calcium channel entry blockers and digoxin (Table 2). However, older adults and those already receiving drugs that slow conduction through the atrioventricular node (eg, beta-blockers or calcium channel blockers) may have resting HRs within the normal range.

If patients remain symptomatic with complaints such as palpitations or fatigue, or prefer restoration of sinus rhythm, additional treatment options are available. This usually involves agents such as amiodarone or sotalol (Table 2), both of which are used in conjunction with direct current electrical cardioversion. These steps often restore normal sinus rhythm and relieve patient symptoms; however, AF often recurs. For patients with recurrent AF and symptoms, invasive procedures such as catheter-based ablation (using heat or extreme cold) may be considered. Catheter-based ablation procedures are curative in 53%−83% of cases;

in selected patients with AF and heart failure, ablation can also reduce heart failure mortality and hospitalizations.[10,11]

The second major treatment goal of AF is to reduce the risk of a stroke. AF is a risk factor for stroke because lack of organized atrial electrical activity often leads to slower atrial blood flow (so-called, “blood pooling”), which can increase the risk for intracardiac blood clots; therefore, the potential exists for embolization of a blood clot to the brain or the periphery. Such embolization, however, can be dramatically reduced with adequate anticoagulation therapy or catheter-based closure of the atrial appendage.[12,13] For decades, warfarin was used almost exclusively for anticoagulation, but within the last decade several new direct oral anticoagulants have been approved in the United States (Table 2). All of these medications have substantial advantages over warfarin but should not be used in AF that is associated with cardiac valvular disease. Ideally, all treatment decisions should weigh the estimated annual risk of stroke against the treatment-related risk of bleeding. Although the presence of AF has been consistently associated with higher mortality rates and incident heart failure,[14] it is unclear whether AF is just a marker for greater underlying disease severity or if AF independently contributes to poorer outcomes.

ROLE OF EXERCISE TESTING AND TRAINING

Exercise Testing

By itself, AF is not an indication for performing an exercise test. However, a graded exercise test can be useful in patients with AF to help assess myocardial ischemia or evaluate chronotropic response to exercise, particularly in those treated for rate control.[1,15] For patients with AF enrolled in a rehabilitation program, an exercise test could help better guide exercise training intensity or quantify cardiorespiratory fitness at baseline or in response to physical training. Exercise testing can also help when titrating a medication to control ventricular rate response or to assess for QRS widening among patients starting a Class 1C antiarrhythmic drug (eg, flecanide).[15,16]

Given that there are no procedures specifically recommended for exercise testing in patients with AF, such testing should follow the principles set forth by the American Heart Association[15] and the American College of Sports Medicine.[16] In the absence of any of the standard indications for stopping an exercise test, patients with AF can be safely exercised up to symptom-limited maximum effort, instead of simply 85% of age-predicted maximum HR. Concerning the latter, it is not uncommon that patients with AF achieve a peak HR that exceeds 100% of age-predicted maximum.[17,18] The use of expired gas exchange analysis can be added as a useful tool to more accurately quantify functional capacity. Prior to testing, those with AF should continue to take medications prescribed for anticoagulation or control of ventricular rate.

Safety—No studies have specifically addressed the safety of exercise testing in patients with AF. In 1968, Hornsten and Bruce performed exercise treadmill tests on 25 male and 40 female patients with AF and compared their responses to an equal number of patients in normal sinus rhythm.[19] They observed that HR at rest, during submaximal exercise, and at peak exercise was higher in both men and women with AF compared to the people in sinus rhythm. No adverse events were reported. Two decades later, Atwood et al reported no adverse complications in 29 men with AF who performed a maximal exercise test.[20] Based on these reports and decades of anecdotal experience, and also giving consideration to the test-related procedures summarized in Table 3, a maximal effort exercise test under adequate supervision is likely associated with a low risk for test-related complications. For those people in sinus rhythm, exercise testing-induced AF occurs in <1% of those who perform a test.[20]

Measuring HR at Rest and During Exercise—Heart rate in patients with AF is best measured by ECG recording or cardiac auscultation. With AF, fluctuations in HR occur constantly both at rest and during exercise, thus making the accurate determination of HR a challenge. Atrial rate in patients with AF is between 400 and 600 beats/min and prior to diagnosis or treatment, the ventricular rate is typically high (ie, rapid ventricular rate) at >100 beats/min. Once adequately treated, usually with a beta-adrenergic blocking agent, the ventricular rate at rest is reduced to between 60 and 80 beats/min, while the atrial rate remains unaffected. Because of interpatient variability in ventricular response, when determining HR by ECG assessment the technique of extrapolating data from a shorter time (eg, 6 sec or a single RR interval) may provide an erroneously slow or fast HR. Instead, count the number of QRS complexes over 10 sec and multiply by 6 to more accurately determine rate at rest and during exercise. In exercise rehabilitation, ECG telemetry systems that provide a visual display of HR usually measure the RR intervals over a relatively short time period to provide a ventricular rate. For that reason, the displayed HR on the ECG monitor typically fluctuates in patients with AF. The amount of change or fluctuation in HR can vary from 1 patient to the next, and is also influenced by the rate controlling medication(s) they are using.

Self-monitoring of HR in patients with AF is challenging. Over a 60-sec period of time, Sneed and Hollerbach compared resting HR in patients with AF using: (1) standard ECG measurement; (2) palpation of the radial pulse; and (3) auscultation of the chest.[21] When compared to HR measured by ECG, they reported that the apical/chest method was more accurate than radial pulse palpation, with the latter associated with a slower apparent HR (ie, pulse deficit). Specifically, heart beats with shortened R to R intervals are associated with less ventricular filling and a resultant lower stroke volume. This makes detecting a radial pulse more difficult due to less blood being ejected into the arterial system. Self-monitoring of HR using radial pulse palpation is not generally recommended because of the inaccuracy associated with the usually short duration of assessment, occurrence of a pulse deficit, and the inability of many patients to palpate their own pulse and count a rapidly changing rate. Although many commercially available technology devices are being investigated for the remote detection and reporting of AF, the accuracy of these devices for measuring HR at rest and during exercise has not been adequately described; therefore, additional research is warranted.[22–24]

Cardiorespiratory Responses during Exercise

Patients with new onset AF often experience an excessive ventricular rate response during low-level activities of daily living. This is also observed during the early, low-level stages of an exercise test, even when the resting HR is controlled.[15] In AF, the net effect of the loss of a normal atrial contraction (aka, atrial kick) is a reduction in cardiac output due to reduced ventricular filling. To help maintain a normal cardiac output response during exercise, the higher ventricular rate represents a compensatory response to the reduced ventricular filling and the associated lower stroke volume. Atwood et al observed that the peak exercise HR of a group of 21 patients with AF and no other known heart disease was significantly higher than a group of 29 subjects in sinus rhythm (189 ± 32 versus 166 ± 24 beats/min, $P < .01$).[20]

To assess the effects of AF on exercise capacity, Atwood and colleagues studied 655 patients who underwent cardioversion.[25] Comparisons were made between those who maintained sinus rhythm following cardioversion versus those who remained in AF, with multiple tests completed over 52 weeks. By week 8 there was a significantly greater (~15%) exercise capacity (ie, exercise time) among those who converted to sinus rhythm. This difference was sustained over the 52 wk. Additionally, patients who converted to sinus rhythm had a significantly lower HR at rest (~25 beats/min) and at peak exercise (~40 beats/min) versus the AF group.

Finally, Atwood et al[20] noted a significantly lower peak oxygen uptake ($\dot{V}O_2$) in AF patients with known heart disease compared to patients with AF but without heart disease (19.1 ± 5.0 versus 22.7 ± 5 mL/kg/min, respectively, $P < .05$). Among patients with heart failure due to systolic dysfunction, peak $\dot{V}O_2$ was ~20% lower in patients with AF (13.8 ± 3.6 mL/kg/min) versus those in sinus rhythm (17.1 ± 5.6 mL/kg/min).[26] In the above 2 studies, there were no differences in either age or peak respiratory exchange ratio between the study groups, and 1 study included males only and, in the other study, 99% were males.[20,26] This suggests that individual effort, sex and age did not play an important role in the observed differences in peak $\dot{V}O_2$.

Exercise Training

Two of the hallmark features of AF are exercise intolerance and diminished quality of life, especially when coexisting with other conditions (eg, heart failure, diabetes, or valvular heart disease). To that end and given that regular exercise is known to improve functional capacity and lessen fatigue, it is often helpful to include exercise training in the care of patients with AF if appropriate control of HR has been achieved. With the above in mind, we first point out that there are only a few small prospective randomized controlled trials that describe the effects of exercise rehabilitation in patients with AF. For patients with AF, this section addresses (1) responses to regular exercise training; (2) the use of exercise rehabilitation in the management of the disease; and (3) the essential elements for prescribing exercise.

Responses or Adaptations to Exercise Training—Across a variety of exercise assessments, such as peak $\dot{V}O_2$, 6-min walk test, power output, and measures of activities of daily living, most studies[27–32] and meta-analyses[33–35] show that aerobic exercise training is consistently associated with modest (10%−15%) improvements in exercise capacity in patients with AF (Table 4). A secondary analysis of patients with heart failure and AF enrolled in the HF-ACTION trial showed small, but significant improvements in both peak $\dot{V}O_2$ and 6-min walk distance after 3 mo for patients undergoing exercise training versus controls ($\dot{V}O_2$ in mL/kg/min: 5 % vs 0%, respectively; 6-min walk distance in m: 6% vs 1%, respectively).[29] Using ratings of perceived exertion and HR to guide intensity, Malmo and colleagues[30] were the first group to apply higher intensity interval training in a cohort of patients with AF and a higher level of fitness at baseline (33 mL/kg/min), and showed a 3.2 mL/kg/min (10%) increase in peak $\dot{V}O_2$.

Similar to exercise capacity, overall and various subcomponent measures of quality of life and health status are typically improved with exercise training[27–35] (Table 4). This includes reductions in the common AF-related symptoms of feeling of tiredness (−26%) and shortness of breath (−33%), as well as symptom frequency and severity.[30,32] Using the Kansas City Cardiomyopathy questionnaire, the HF-ACTION trial showed small improvements (+3.1 points) in health status among patients with AF randomized to exercise training versus usual care.[29] It is important to point out, however, that the sample sizes and the quality of the evidence in most of the studies reported to date have been rated as low.[33] Therefore, additional multi-site trial-level evidence involving larger samples is needed to better describe the impact of exercise training on exercise capacity, health status, and quality of life in patients with AF.

A large randomized clinical trial designed to evaluate the safety of exercise training or its effect on clinical outcomes in patients with AF has not been undertaken to date. A secondary analysis of the HF-ACTION trial showed that among patients with chronic heart failure, there was no interaction between AF status and exercise training on the clinical outcomes of combined all-cause mortality or hospitalization, all-cause mortality alone, or combined cardiovascular mortality or heart failure hospitalization.[29] In a systematic review by Giacomantonio et al,[35] there were no major adverse events during exercise training among those with AF; however, several studies included in that analysis did not report safety information.

Exercise Training as a Therapy in the Management of AF—Using different measures to assess AF burden, several studies have investigated the use of exercise training as a therapy to help manage the condition. In a study of 51 patients with paroxysmal or persistent AF, Malmo and colleagues used an implanted loop recorder to measure percentage of time in AF during a 4-wk period to assess the effect of 12 wk of higher intensity interval training versus usual care.[30] They observed that time in AF decreased from 8.1% to 4.8% with exercise training versus an increase in controls from 10.4% to 14.6%, ($P = .001$ for the mean difference in change between groups). Using Holter ECG monitoring in an uncontrolled trial of 10 patients with permanent AF who underwent 4 mo of exercise training, Plisiene et al reported a 12% decrease in 24-hr mean ventricular rate.[36] They also reported an approximate 8% decrease in mean ventricular rate during all levels of submaximal exercise.

An uncontrolled, prospective observational study by Pathak et al[37] involved 308 obese patients with paroxysmal or persistent AF who were entered into a risk factor management program that included structured exercise; they showed that those who improved cardiorespiratory fitness by ≥2 metabolic equivalents of task (METs) over 24 or more mo experienced greater weight loss, blood pressure control, and improved cardiac structure compared to patients achieving a <2 METs gain in fitness. Among patients with a greater gain in fitness, there were also a greater reduction in AF burden (ie, frequency and duration of AF; symptoms) and higher arrhythmia-free survival rates. In this study, the recommendation for exercise volume was 200 min per wk of moderate intensity (ie, up to 85% of age-predicted maximum). Although much more research is needed, in general, regular aerobic exercise seems to have a modest, favorable effect on AF burden.

Prescribing Exercise in Patients with AF—Since a primary goal for exercise training in patients with AF is to reverse exercise intolerance as measured by peak $\dot{V}O_2$, the principle of specificity of training dictates that large-muscle, whole-body activities (eg, walking, cycling) that stimulate the cardiorespiratory system be employed (Tables 5 and 6). Additionally, since disorders of skeletal muscle strength, function and endurance are likely common as well in these patients, consideration for the incorporation of strength training into the over-all exercise plan for selected patients may be justified. However, there are no prospective, controlled resistance training-specific trials that specifically involve patients with AF.

In addition to the type of exercise, there are 3 other training factors to consider in order to impose the necessary training stimulus or overload[38]; these factors are intensity, duration and frequency of training (Table 6). In all patients with AF, the clinical exercise physiologist or other exercise professional responsible for writing the exercise prescription and overseeing patient progress, needs to ensure that the volume of exercise performed each week is slowly but consistently adjusted over time[38]. For most patients, progressing up to the initially targeted volume of exercise should require between 2 and 3 wk.

Duration and frequency of effort should both be progressively up-titrated before intensity is increased, to a minimum target amount of 150 min/wk (eg, 30 min, 5 times/wk). With respect to prescribing exercise training intensity, the common approach involving the HR reserve method likely does not apply for 2 reasons. First, such an approach requires a measurement of peak HR from a maximal exercise test, which is not routinely completed for patients enrolled in cardiac rehabilitation. Second, the variable HR response to exercise in AF previously discussed makes titrating training workloads to a prescribed target HR range a challenge in these patients. The latter might be overcome by calculating a HR from an ECG telemetry print out that was recorded over a longer time interval (ie, number of QRS complexes in a 30-sec strip), but this approach may prove impractical during an actual rehabilitation session. Interestingly, a recent controlled trial by Malmo et al[30] that involved higher intensity interval training in patients with nonpermanent AF used the HR reserve method (set at 85% to 95% of measured peak HR) during periods of sinus rhythm. During periods of AF, workloads were simply matched to those trained at during periods of sinus rhythm (regardless of the HR while in AF), aided with the Borg ratings of perceived exertion (RPE) 6 to 20 scale.

Although prescribing exercise intensity can be a challenge in patients with AF, some valid and helpful tools are available. For patients with heart failure and AF, the American College of Sports Medicine recommends guiding exercise intensity at 11–14 on the RPE scale.[39] Shown to be a feasible and valid method to guide exercise intensity across a variety of patient populations, the RPE scale requires that patients be correctly taught and demonstrate an understanding of how to properly express their level of exertion. Another strategy for guiding exercise intensity in patients with AF is the Talk Test, which has experienced widespread use and validation in other clinical populations and in free-living conditions (Table 6).[40–42] This method is based on the premise that it is difficult for patients to carry on a conversation when exercising at or above ventilatory threshold, thus representing the basis for the instruction that patients exercise at the highest intensity at which they can still comfortably carry on a conversation.[42–44] For most patients, this represents training at an intensity that approximates 60% to 75% of peak $\dot{V}O_2$.

Regarding resistance training, although 1 controlled trial included muscle strengthening exercises as part of a comprehensive exercise intervention in patients with AF,[32] no prospective controlled trials have reported on the responses to resistance training only in these patients. Following treatment with catheter ablation for AF, Risom et al randomized 210 patients at 1 mo after the procedure to cardiac rehabilitation, which included some strength exercises, versus usual care.[45] Compared to usual care, peak $\dot{V}O_2$, but not self-rated mental health, was improved with cardiac rehabilitation. Nonserious events, mainly musculoskeletal complaints, were more frequent in the cardiac rehabilitation group, but no data were provided regarding any effects on skeletal muscle function. For clinicians that wish to incorporate resistance training into the care of their patients with AF, it is likely prudent to consider methods advanced for healthy individuals and patients with other cardiovascular diseases (Table 6).[16,38,46]

SUMMARY AND FUTURE DIRECTIONS

Atrial fibrillation is a disorder that is easily diagnosed and associated with well-defined treatment guidelines. However, despite AF representing a common comorbidity among patients enrolled in rehabilitation programs, there is a paucity of controlled trials that use standard laboratory methods and endpoints to evaluate the utility and effectiveness of exercise testing and training in these patients. To that end, the questions surrounding the impact of aerobic and resistance training in patients with AF are many, including safety; quality of life clinical outcomes; and central, autonomic, and peripheral (ie, skeletal muscle, vascular) adaptations. Both larger observational and multicenter trials involving standard and novel evaluation and training methods are needed to better address these issues, with a special emphasis placed on the elderly, women, and vulnerable populations.

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Table 1.

Classification of Atrial Fibrillation by Duration and Persistence

Type or Class of Atrial Fibrillation	Diagnostic Criteria
Paroxysmal	An episode of AF that spontaneously converts back to normal sinus rhythm within 7 d.
Persistent	Patient requires electrical or chemical/drug cardioversion to restore normal sinus rhythm.
Permanent	Present for >6 mo or the patient and physician decide to no longer attempt to restore normal sinus rhythm.

Abbreviation: AF, atrial fibrillation.

Table 2.

Common Medications Used in the Treatment of Atrial Fibrillation

Rhythm Control Strategy	Usual Dose	Treatment Notes
Amiodarone	Initial load is 10 g Maintenance dose is 200 to 400 mg daily	Effective for multiple types of arrhythmias; very slowly metabolized and excreted; multiple side effects which include pulmonary, hepatic, and thyroid fibrosis.
Sotalol	80 to 160 mg twice daily	Prolongs QT interval and requires monitoring; contraindicated with reduced ejection fraction or left ventricular hypertrophy; useful in patients with coronary artery disease
Rate Control Strategy		
Beta-adrenergic blocking agents	**Can worsen asthma, hypoglycemia unawareness, erectile dysfunction**	
Metoprolol	25 to 100 mg twice daily	Most commonly used beta-blocker, available in an extended release formula
Carvedilol	3.125 mg to 25 mg twice daily	Effective antihypertensive; also indicated for heart failure with reduced ejection fraction
Calcium channel blockers (Nondihydropyridine)	**Should be avoided in heart failure with reduced ejection fraction**	
Diltiazem	120 to 420 mg daily (controlled/ extended release)	Also useful for hypertension and angina; immediate release formula requires dosing every 6–8 hr
Other		
Digoxin	0.0625 to 0.25 mg daily	Most useful in combination with beta-blockers; requires monitoring with blood level testing; toxicity possible, particularly in hypokalemia; must reduce dose in patients with kidney disease
Anticoagulation		
Conventional		
Aspirin	81 to 325 mg daily	Mostly ineffective for stroke prevention; use only for patients at very high risk of bleeding
Warfarin (Coumadin)	0.5 to 10 mg daily	Very narrow therapeutic window; requires obtaining frequent blood samples and involves dose adjustments; multiple drug and diet interactions
Direct Oral Anticoagulants	**Not to be used in prosthetic heart valves or mitral stenosis; does not need monitoring; generics not available; minimal drug interactions; reduce dose in patients with kidney disease; drugs are more equivalent than different**	
Apixaban (Eliquis)	2.5 to 5 mg twice daily	Lowest risk of bleeding; increases diltiazem blood levels by 40%
Dabigatran (Pradaxa)	75 to 150 mg twice daily	Lowest risk of stroke; occasionally causes dyspepsia; reversal agent available
Rivaroxaban (Xarelto)	15 to 20 mg daily	Should be taken with food

Table 3.

Important Exercise Testing Considerations and Procedures in Patients with Atrial Fibrillation

Acute Physiologic Adjustments • Due to loss of a normal atrial contraction and an associated reduction in cardiac output, exercise capacity in patients with AF is 15% to 20% below that of people in sinus rhythm. • Heart rate at rest, during submaximal exercise, and at peak exercise is often higher in patients with AF when compared to people in sinus rhythm. • Peak ventricular rate often exceeds age-predicted maximum.
Testing Considerations and Procedures • Adopt testing principles used for patients without AF. • Patients should undergo testing while taking effective rate-controlling and anticoagulation medications. • Exercise testing can help with titrating medications that target ventricular control during exertion. • Sign- and symptom-limited testing is appropriate. • An exercise test should not be performed in an AF patient with an uncontrolled, tachycardic ventricular rate. • There is relatively limited data addressing the safety of exercise testing in patients with AF; current data suggests that maximal effort under proper supervision is appropriate.

Abbreviation: AF, atrial fibrillation.

Table 4.

Physiologic and Clinical Responses to Aerobic Exercise Training in Patients with Atrial Fibrillation

Parameter or Outcome	Response or Adaptation
Exercise capacity (eg, 6-min walk distance, peak oxygen uptake)	Modestly improved, 10%–15%
Skeletal muscle strength, endurance or histochemistry	Insufficient data
Clinical responses: AF burden (time in AF, ventricular rate at rest and during exercise)	Generally favorable responses, with less time in AF and lower ventricular rate at rest and during exercise
Health status or quality of life	Generally improved across most sub-measures
Clinical outcomes: mortality, rehospitalization	Insufficient data

Abbreviation: AF. atrial fibrillation.

Table 5.

Exercise Prescriptions used in Randomized Controlled Trials Involving Exercise–based Cardiac Rehabilitation in Patients with Atrial Fibrillation

	Exercise Prescription					
		Duration				
Study Sample Size; Mean Age; Primary Disorder	**Frequency (d/wk)**	**Min per Wk**	**Number of Wk**	**Intensity**	**Modalities**	**Comments**
Hegbom et al (2007)[32] n=30; 64 yr; chronic AF	3	225	8	70%-90% maximum HR	Aerobic	Strengthening exercises for back, thighs and abdomen
Osbak et al (2011)[31] n=49; 70 yr; permanent AF	3	Minimum of 90	12	70% of maximal exercise capacity; 14–16 on Borg scale	C, W, R, IT	Subjects encouraged to also do 30 min of light exercise daily
Malmo et al (2016)[30] n=51; 59 yr; nonpermanent AF	3	75	12	4 min work by 4 min recovery interval training, up to 95% peak HR; 11–14 on Borg scale	W, R	First full, formal evaluation of higher intensity interval training
Luo et al (2017)[29] n=1984; 59 yr; HF with AF or SR]	3	90 for first 3 mo, then 120 for duration of the trial	Minimum of 52	11 to 14 on Borg scale	C, W	Secondary analysis from an exercise training trial evaluating clinical outcomes in patients with HF

Abbreviations: AF, atrial fibrillation; C, cycling; HF, heart failure; HR, heart rate; IT, interval training; R, running; SR, sinus rhythm; W, walking.

Table 6.

Exercise Prescription for Patients with Atrial Fibrillation

Training Parameter	Recommendation
Aerobic or Cardiorespiratory	
Type of activity	Aerobic, dynamic such as walking or cycling
Intensity	Rhythm = AF • RPE of 11–14 on Borg 6–20 scale • Talk Test; fastest pace, while still being able to comfortably carry-on a conversation Rhythm = Sinus • 55% to 80% of HRR[a]
Frequency of sessions/wk[b]	3–5; most, if not all, days of the wk
Duration/session[b]	30–60 min
Muscular Strength and Endurance[c]	
Type of activity	Higher repetition, lower resistance muscle specific exercises using fixed weight machines and hand-held weights for 4–6 primary muscle groups; avoid free-weights
Intensity	50%–70% of 1 repetition maximum for lifts involving the hips and lower body; 40%–70% of 1 repetition maximum for lifts involving the upper body.
Frequency	1–2 d/wk; 1–2 sets/d for each muscle group or lift; 10–15 repetitions/set
Duration	Total time = 12–20 min; contraction speed = 6 sec (3 sec concentric and 3 sec eccentric); rest to work ratio ≥2 to 1

Abbreviations: AF, atrial fibrillation; HRR, heart rate reserve; RPE, ratings of perceived exertion.

[a]HRR computed as (measured peak heart rate – seated resting heart rate) x percent training level (expressed as a decimal) + seated resting heart rate.

[b]Target amount = 150 min/wk.

[c]No definitive, disease-specific guidelines currently exist for prescribing resistance training to patients with atrial fibrillation. In the absence of such, training methods advanced for healthy individuals or patients with cardiovascular diseases could be adapted and considered.[16,38,46]